Remelting of a solidified high-Mg andesite magma: a possibe orgin of sanukitoid

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The Oto-Zan lava flow on Shodo-Shima Island, SW Japan, which was emplaced in middle Miocene times in the Setouchi volcanic belt, is composed of phenocryst-poor, plagioclase-aphyric andesites (sanukitoids). It forms a composite lava flow; augite-olivine andesite at its base, via. olivine-augite-orthopyroxene andesite, to augite-orthopyroxene andesite with increasing height. Element abundances also change in accordance with the phenocryst assemblage (e.g., 58-63 wt.%, 7-5 wt.%, 100-130 ppm for SiO2, MgO and Ni), although Sr-Nd-Pb isotopic compositions are rather constant throughout the lava flow. The sanukitoid at the base is a high-Mg andesite and contains Mg-rich (up to Fo90) and Ni-rich (0.6 wt.% NiO in maximum) olivine and Cr-rich chromite with Cr/(Cr+Al+Fe3+) of higher than 0.7, suggesting that the parental magma was a mantle-derived hydrous HMA magma that originally contained ca.7wt.% H2O. However, Oto-Zan sanukitoids contain little H2O and are compact with few vesicles. This apparent paradox can be resolved by solidification of a hydrous HMA magma with release of H2O and remelting of such a H2O-deficient HMA pluton within the crust. Mixing between felsic melts interstitially distributed within such a pluton and remolten HMA magmas may reasonably account for the presence of disequilibrium petrographic signatures observed in the rather differentiated sanukitoids comprising the upper portion of the composite lava flow.

A H2O-poor, non-porous and phenocrysts-poor HMAlava flow is paradoxical, as a mantle-derived HMA magma contains a large amount of H2O. In order to assess this apparent dilemma, melting experiments at 0.3 GPa in the presence of 0.7, 1.5 and 2.1 wt.% H2O have been conducted on a sample of HMA from the basal part of the Oto-Zan composite lava flow. The liquid lines of descent obtained for the HMA magma do not fit the chemical variation trends observed in the Oto-Zan lava, suggesting a negligible role of fractional crystallization in magmatic differentiation. Instead, mixing of a HMA magma with a differentiated felsic melt can reasonably explain the Oto-Zan trends. This felsic melt would have coexisted with amphibole, biotite, plagioclase and Fe-Ti oxide in addition to pyroxene. This is consistent with the relative depletions in Sr, K, Rb, and Ti observed for the Oto-Zan lava. These experimental results, together with the previously reported petrographical and geochemical characteristics of the Oto-Zan composite lava flow may provide a better understanding of the origin of the characteristic HMAs. We propose a model whereby a hydrous mantle-derived HMA magma crystallizes extensively within the crust, resulting in the formation of a HMA pluton and causing liberation of H2O from the magma system. The HMA pluton, in which interstitial rhyolitic melts still remain, is then heated from the base by intrusion of a high-T basalt magma, forming a boundary layer at the base of the pluton and producing a rather H2O-defficient HMA magma. During ascent, this secondary HMA magma entrains the overlying interstitial rhyolitic melt, resulting in variable self-mixing. A zoned magma reservoir, comprising more felsic magmas upwards, forms at the top of the HMA pluton. More effective upwelling of more mafic, and hence less viscous magmas through a propagated vent finally results in the emplacement of composite lava flow such as the Oto-Zan.